

CLAIMS

WHAT IS CLAIMED:

1. An apparatus, comprising:

5 a body having a movable pressure barrier positioned therein, said movable pressure barrier defining first and second chambers therein;

a configurable flow path in fluid communication with said first and second chambers; and

at least one valve for configuring said flow path in a first state wherein fluid may flow

within said flow path only in a direction from said first chamber toward said

10 second chamber, and a second state wherein fluid within said flow path may flow

in both directions between said first and second chambers.

2. The apparatus of claim 1, wherein said configurable flow path is defined in said movable pressure barrier.

15 3. The apparatus of claim 1, wherein said at least one valve is coupled to said movable pressure barrier.

20 4. The apparatus of claim 1, wherein said configurable flow path is configured in said first or second states based upon a position of said movable pressure barrier within said body.

5. The apparatus of claim 1, wherein said configurable flow path is configured in said first or second states based upon said movable pressure barrier being at a first or a second location, respectively, within said body.

5 6. The apparatus of claim 1, wherein said at least one valve is coupled to said movable pressure barrier and said first and second states of said configurable flow path may be established by engaging said at least one valve with at least one surface of said body.

10 7. The apparatus of claim 1, wherein said at least one valve is adapted to configure said flow path in a third state wherein fluid may flow in said flow path only in a direction from said second chamber toward said first chamber.

8. The apparatus of claim 1, wherein, in said first state, fluid may flow from said first chamber into said second chamber.

15 9. The apparatus of claim 4, further comprising an electric motor operatively coupled to said movable pressure barrier, said motor adapted to control a position of said movable pressure barrier to thereby establish said first and second states.

20 10. The apparatus of claim 1, wherein said at least one valve is coupled to said movable pressure barrier and wherein the apparatus further comprises an electric motor that is operatively coupled to said movable pressure barrier and adapted to, when energized, move said

pressure barrier to thereby establish said first and second states by engaging said at least one valve with said body.

11. The apparatus of claim 1, wherein said movable pressure barrier is a piston.

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12. The apparatus of claim 1, further comprising a camming device operatively coupled to said moveable pressure barrier wherein said movable pressure barrier may be positioned at a location such that said camming device exerts a force that tends to move said pressure barrier within said body.

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13. The apparatus of claim 12, wherein said device further comprises a structural member operatively coupled to said movable pressure barrier, said structural member extending through a housing and said camming device is operatively coupled between said structural member and said housing.

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14. The apparatus of claim 1, wherein said flow path is defined in said pressure barrier and said at least one valve comprises a check valve coupled to said pressure barrier.

15. The apparatus of claim 1, wherein said flow path is defined in said pressure barrier and said at least one valve comprises a three-way valve coupled to said pressure barrier.

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16. The apparatus of claim 1, further comprising a hydraulically actuated device in fluid communication with one of said first and second chambers, said hydraulically actuated device adapted to be actuated by a pressure created in said one of said first and second chambers.

5 17. The apparatus of claim 1, further comprising a SCSSV valve in fluid communication with one of said first and second chambers, said SCSSV valve adapted to be biased in an open position by a pressure created in said one of said first and second chambers.

10 18. An apparatus, comprising:

a body having a movable pressure barrier positioned therein, said movable pressure barrier defining first and second chambers therein;

a configurable flow path defined in said movable pressure barrier, said configurable flow path being in fluid communication with said first and second chambers; and

15 at least one valve coupled to said movable pressure barrier for configuring said flow path in a first state wherein fluid may flow within said flow path only in a direction from said first chamber toward said second chamber, and a second state wherein fluid within said flow path may flow in both directions between said first and second chambers.

20 19. The apparatus of claim 18, wherein said configurable flow path is configured in said first or second states based upon a position of said movable pressure barrier within said body.

20. The apparatus of claim 18, wherein said first and second states of said configurable flow path may be established by engaging said at least one valve with at least one surface of said body.

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21. The apparatus of claim 18, wherein said at least one valve is adapted to configure said flow path in a third state wherein fluid may flow in said flow path only in a direction from said second chamber toward said first chamber.

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22. The apparatus of claim 18, wherein, in said first state, fluid may flow from said first chamber into said second chamber.

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23. The apparatus of claim 18, further comprising an electric motor operatively coupled to said movable pressure barrier, said motor adapted to control a position of said movable pressure barrier to thereby establish said first and second states.

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24. The apparatus of claim 18, further comprising an electric motor that is operatively coupled to said movable pressure barrier and adapted to, when energized, move said pressure barrier to thereby establish said first and second states by engaging said at least one valve with said body.

25. The apparatus of claim 18, wherein said movable pressure barrier is a piston.

26. The apparatus of claim 18, further comprising a camming device operatively coupled to said moveable pressure barrier wherein said movable pressure barrier may be positioned at a location such that said camming device exerts a force that tends to move said pressure barrier within said body.

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27. The apparatus of claim 26 wherein said device further comprises a structural member operatively coupled to said movable pressure barrier, said structural member extending through a housing and said camming device is operatively coupled between said structural member and said housing.

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28. The apparatus of claim 18, wherein said valve comprises a check valve.

29. The apparatus of claim 18, wherein said at least one valve comprises a three-way valve.

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30. The apparatus of claim 18, further comprising a hydraulically actuated device in fluid communication with one of said first and second chambers, said hydraulically actuated device adapted to be actuated by a pressure created in said one of said first and second chambers.

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31. The apparatus of claim 18 further comprising a SCSSV valve in fluid communication with one of said first and second chambers, said SCSSV valve adapted to be biased in an open position by a pressure created in said one of said first and second chambers.

32. An apparatus, comprising:

a body having a movable pressure barrier positioned therein, said movable pressure barrier defining first and second chambers therein;

5 a configurable flow path defined in said movable pressure barrier, said configurable flow path being in fluid communication with said first and second chambers; and

at least one check valve coupled to said movable pressure barrier and positioned in said flow path, said check valve adapted to configure said flow path in a first state wherein fluid may flow within said flow path only in a direction from said first chamber toward said second chamber, and a second state wherein fluid within
10 said flow path may flow in both directions between said first and second chambers.

33. The apparatus of claim 32, wherein said configurable flow path is configured in at least one of said first and second states based upon a position of said movable pressure barrier within said body.
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34. The apparatus of claim 32, wherein at least one of said first and second states of said configurable flow path may be established by engaging said at least one check valve with at least one surface of said body.
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35. The apparatus of claim 32, wherein, in said first state, fluid may flow from said first chamber into said second chamber.

36. The apparatus of claim 33, further comprising an electric motor operatively coupled to said movable pressure barrier, said motor adapted to control a position of said movable pressure barrier to thereby establish said first and second states.

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37. The apparatus of claim 32, further comprising an electric motor that is operatively coupled to said movable pressure barrier and adapted to, when energized, move said pressure barrier to thereby establish said second state by engaging said at least one check valve with said body.

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38. The apparatus of claim 32, wherein said movable pressure barrier is a piston.

39. The apparatus of claim 32, further comprising a second check valve positioned in a second flow path in fluid communication with said second chamber, said second valve having a closed state that prevents a flow of a fluid from said second flow path into said second chamber and an open state that allows a fluid in said second flow path to flow into said second chamber.

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40. The apparatus of claim 39, wherein said closed and open states of said second check valve is established based upon a position of said movable pressure barrier in said body.

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41. The apparatus of claim 39, wherein said open state of said second check valve is established by said movable pressure barrier engaging at least a portion of said second check valve.

42. The apparatus of claim 32, further comprising a camming device operatively coupled to said moveable pressure barrier wherein said movable pressure barrier may be positioned at a location such that said camming device exerts a force that tends to move said pressure barrier within said body.

43. The apparatus of claim 42 wherein said device further comprises a structural member operatively coupled to said movable pressure barrier, said structural member extending through a housing and said camming device is operatively coupled between said structural member and said housing.

44. The apparatus of claim 32, further comprising a hydraulically actuated device in fluid communication with one of said first and second chambers, said hydraulically actuated device adapted to be actuated by a pressure created in said one of said first and second chambers.

45. The apparatus of claim 32, further comprising a SCSSV valve in fluid communication with one of said first and second chambers, said SCSSV valve adapted to be biased in an open position by a pressure created in said one of said first and second chambers.

46. A device, comprising:

a body having a movable pressure barrier positioned therein, said movable pressure barrier defining at least one chamber therein; and

an electric motor operatively coupled to said movable pressure barrier, said electric motor adapted to:

when energized, create a resistance force to a pressure force created by a pressure existing in said chamber; and,

5 when de-energized, allow said pressure barrier in said chamber to move in response to said pressure force to a position within said body wherein said pressure within said chamber may be released from said chamber.

10 47. The device of claim 46, further comprising a hydraulically actuable device in fluid communication with said chamber, wherein said device is adapted to be actuated by said pressure existing in said chamber when said motor is in its energized state.

15 48. The device of claim 46, further comprising a SCSSV in fluid communication with said chamber, wherein said SCSSV is adapted to be maintained in an open position by said pressure existing in said chamber when said motor is in its energized state.

20 49. The device of claim 46, further comprising at least one valve that may be actuated to establish a flow path for releasing said pressure from said chamber, said valve being actuated when said pressure barrier moves to said position within said body.

50. The device of claim 46, further comprising at least one valve coupled to said pressure barrier that may be actuated to establish a flow path for releasing said pressure from

said chamber, said valve being actuated when said pressure barrier moves to said position within said body.

51. The device of claim 46, further comprising at least one valve coupled to said
5 movable pressure barrier that may be actuated to establish a flow path for releasing said pressure from said chamber, said at least one valve being actuated by engaging said at least one valve with at least one surface of said body.

52. The device of claim 46, wherein said movable pressure barrier is a piston.

10 53. The device of claim 46, further comprising a camming device operatively coupled to said moveable pressure barrier wherein said movable pressure barrier may be positioned at a location such that said camming device exerts a force that tends to move said pressure barrier within said body.

15 54. The apparatus of claim 53 wherein said device further comprises a structural member operatively coupled to said movable pressure barrier, said structural member extending through a housing and said camming device is operatively coupled between said structural
20 member and said housing.

55. The device of claim 46, wherein said flow path is defined in said pressure barrier and said at least one valve comprises a check valve coupled to said pressure barrier.

56. The device of claim 46, wherein said flow path is defined in said pressure barrier and said at least one valve comprises a three-way valve coupled to said pressure barrier.

5 57. A device, comprising:

a body having a movable pressure barrier positioned therein, said movable pressure barrier defining at least one chamber therein; and

an electric latch adapted to:

when energized, prevent said movable pressure barrier from moving within said

10 body in response to a pressure force created by a pressure existing in said chamber; and,

when de-energized, allow said movable pressure barrier in said chamber to move

in response to said pressure force to a position within said body wherein said pressure within said chamber may be released.

15 58. The device of claim 57, wherein said movable pressure barrier has a structural member operatively coupled thereto, and said electric latch is adapted to, when energized, engage at least a portion of said structural member.

20 59. The device of claim 57, wherein said movable pressure barrier is a piston and said structural member is a rod operatively coupled to said piston.

60. The device of claim 57, further comprising an electric motor operatively coupled to said movable pressure barrier, said electric motor adapted to move said movable pressure barrier within said body.

5 61. The device of claim 57, further comprising a hydraulically actuatable device in fluid communication with said chamber, wherein said device is adapted to be actuated by said pressure existing in said chamber, and said latch, in said energized state, is adapted to prevent movement of said pressure barrier to thereby maintain said pressure within said chamber.

10 62. The device of claim 57, further comprising a SCSSV in fluid communication with said chamber, wherein said SCSSV is adapted to be maintained in an open position by said pressure existing in said chamber, and said latch, in said energized state, is adapted to prevent movement of said pressure barrier to thereby maintain said pressure within said chamber.

15 63. The device of claim 57, further comprising at least one valve, said at least on valve being actuatable to establish a flow path for releasing said pressure from said chamber, said valve being actuated when said electric latch, in said de-energized state, allows said pressure barrier to move to said position within said body.

20 64. The device of claim 57, further comprising at least one valve coupled to said pressure barrier, said at least one valve actuatable to establish a flow path for releasing said pressure from said chamber, said valve being actuated when said electric latch, in said de-energized state, allows said pressure barrier to move to said position within said body.

65. The device of claim 57, further comprising at least one valve coupled to said movable pressure barrier, said at least one valve actatable to establish a flow path for releasing said pressure in said chamber, said at least one valve being actuated when said electric latch, in
5 said de-energized state, allows said pressure barrier to move to said position where said at least one valve engages at least one surface of said body.

66. The device of claim 57, wherein said movable pressure barrier is a piston.

10 67. The device of claim 57, further comprising a camming device operatively coupled to said moveable pressure barrier wherein said movable pressure barrier may be positioned at a location such that said camming device exerts a force that tends to move said pressure barrier within said body.

15 68. The apparatus of claim 67 wherein said device further comprises a structural member operatively coupled to said movable pressure barrier, said structural member extending through a housing and said camming device is operatively coupled between said structural member and said housing.

20 69. A device, comprising:

a body having a movable pressure barrier positioned within said body, said pressure barrier defining at least one chamber within said body; and

an electric motor operatively coupled to said movable pressure barrier, said motor adapted to:

create a desired working outlet pressure for said device by causing movement of said pressure barrier within said body;

5 move said pressure barrier to a first position to thereby allow said working pressure to exist within said chamber and, when said motor is energized, create a resistance force to a pressure force created by said working pressure existing in said chamber; and

10 when said motor is de-energized, allow said pressure barrier to move in response to said pressure force to a second position where said working pressure within said chamber may be released from said chamber.

70. The device of claim 69, further comprising a hydraulically actuatable device in fluid communication with said chamber, wherein said device is adapted to be actuated by said working pressure existing in said chamber when said motor is in its energized state.

71. The device of claim 69, further comprising a SCSSV in fluid communication with said chamber, wherein said SCSSV is adapted to be maintained in an open position by said working pressure in said chamber when said motor is in its energized state.

72. The device of claim 69, further comprising at least one valve that may be actuated when said pressure barrier is moved to said second position to establish a flow path for releasing said pressure from said chamber.

73. The device of claim 69, further comprising at least one valve coupled to said pressure barrier, said at least one valve being actuatable when said pressure barrier is moved to said second position to establish a flow path for releasing said pressure from said chamber.

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74. The device of claim 69, further comprising at least one valve that is coupled to said movable pressure barrier and, when said pressure barrier is in said second position, said at least one valve engages at least one surface of said body.

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75. The device of claim 69, wherein said movable pressure barrier is a piston.

76. The device of claim 69, further comprising a camming device operatively coupled to said moveable pressure barrier wherein said movable pressure barrier may be positioned at a location such that said camming device exerts a force that tends to move said pressure barrier within said body.

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77. The apparatus of claim 76, wherein said device further comprises a structural member operatively coupled to said movable pressure barrier, said structural member extending through a housing and said camming device is operatively coupled between said structural member and said housing.

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78. A device, comprising:
a first body;

a first movable pressure barrier positioned within said first body, said first movable pressure barrier defining a first chamber and a second chamber within said first body;

a second body;

5 a second movable pressure barrier positioned within said second body, said second movable pressure barrier defining a third chamber and a fourth chamber within said second body, wherein said first chamber is in fluid communication with said third chamber and said second chamber is in fluid communication with said fourth chamber;

10 an output shaft coupled to said second movable pressure barrier; and

a controllable valve that is adapted to configure a flow path between said first and second chambers.

79. The device of claim 78, further comprising an electric motor operatively coupled
15 to said first movable pressure barrier.

80. The device of claim 78, wherein said controllable valve is coupled to said first movable pressure barrier.

20 81. The device of claim 78, wherein said controllable valve is positionable in a first state to allow said fluid to flow only in a direction from said first chamber to said second chamber.

82. The device of claim 78, wherein said controllable valve is positionable in a second state to allow said fluid to flow only in a direction from said second chamber to said first chamber.

5 83. The device of claim 78, wherein said controllable valve is positionable in a third state wherein said fluid may flow in both directions between said first and second chambers.

84. The device of claim 78, wherein said controllable valve is positionable in:
a first state to allow said fluid to flow only in a direction from said first chamber to said
10 second chamber; and
a second state to allow said fluid to flow only in a direction from said second chamber to
said first chamber.

85. The device of claim 78, wherein said controllable valve is positionable in:
15 a first state to allow said fluid to flow only in a direction from said first chamber to said
second chamber;
a second state to allow said fluid to flow only in a direction from said second chamber to
said first chamber; and
a third state wherein said fluid may flow in both directions between said first and second
20 chambers.

86. The device of claim 78, wherein said flow path is defined in said first movable pressure barrier.

87. The device of claim 78, wherein said controllable valve configures said flow path between said first and second chambers based upon a position of said first movable pressure barrier within said first body.

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88. The device of claim 78, wherein said controllable valve configures said flow path between said first and second chambers in a first state or a second state based upon said moveable pressure barrier being positioned at a first and second location, respectively, within said body.

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89. The device of claim 78, wherein said controllable valve is coupled to said first movable pressure barrier and said flow path between first and second chambers is configurable by engaging said controllable valve with at least one surface of said first body.

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90. The device of claim 78, further comprising an electric motor operatively coupled to said first movable pressure barrier, said electric motor adapted to control a position of said first movable pressure barrier to thereby control said controllable valve.

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91. The device of claim 78, further comprising an electric motor that is operatively coupled to said first movable pressure barrier and adapted to, when actuated, move said first pressure barrier to thereby cause said controllable valve to engage said body.

92. The device of claim 78, wherein each of said first and second movable pressure barriers is a piston.

93. The device of claim 78, further comprising a camming device operatively coupled to said moveable pressure barrier wherein said movable pressure barrier may be positioned at a location such that said camming device exerts a force that tends to move said pressure barrier within said body.

94. The apparatus of claim 93, wherein said device further comprises a structural member operatively coupled to said movable pressure barrier, said structural member extending through a housing and said camming device is operatively coupled between said structural member and said housing.

95. An apparatus, comprising:

a body having a movable pressure barrier positioned therein, said movable pressure barrier defining first and second chambers therein;
a configurable flow path in fluid communication with said first and second chambers; and
means for configuring said flow path in a first state wherein fluid may flow within said flow path only in a direction from said first chamber toward said second chamber,
and a second state wherein fluid within said flow path may flow in both directions between said first and second chambers.

96. The apparatus of claim 95, wherein said means for configuring said flow path comprises at least one valve.

97. The apparatus of claim 95, wherein said means for configuring said flow path is
5 coupled to said movable pressure barrier.

98. The apparatus of claim 95, wherein means for configuring said flow path is
coupled to said movable pressure barrier and said first and second states of said configurable
flow path may be established by engaging said means for configuring said flow path with at least
10 one surface of said body.

99. A device, comprising:

a body having a movable pressure barrier positioned therein, said movable pressure
barrier defining at least one chamber therein; and

15 an electrically powered resistance means operatively coupled to said movable pressure
barrier, said resistance means adapted to:

when energized, create a resistance force to a pressure force created by a pressure
existing in said chamber; and,

when de-energized, allow said pressure barrier in said chamber to move in
20 response to said pressure force to a position within said body wherein said
pressure within said chamber may be released from said chamber.

100. The device of claim 99, wherein said resistance means comprises an electric motor.

101. The device of claim 99, wherein said resistance means comprises an electric latch.

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102. A device, comprising:

a body;

a movable pressure barrier positioned in said body, wherein said movable pressure barrier defines at least one chamber within said body; and

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said device being configurable in at least two operational modes, each of said operational modes being selectable by movement of said pressure barrier through a switching series of positions.

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103. The device of claim 102, wherein each of said at least two operational modes has a beginning and an end, said switching series of positions has a transition position, and said transition position defines an end of one of said operational modes and a beginning of another of said operational modes.

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104. The device of claim 103, further comprising a biasable switch capable of enabling each of said at least two modes of operation, said switch in said transition position is biasable by engagement with at least one of said movable pressure barrier and said body.

105. The device of claim 104, further comprising a valve operatively connected to said switch, wherein said valve controls said at least two operational modes.

106. The device of claim 102, wherein said movable pressure barrier has at least one transition position, and said switching series of positions includes said pressure barrier passing through said at least one transition position.

107. The device of claim 102, wherein said pressure barrier is operatively connected to a motor and gear linkage.

108. The device of claim 102, further comprising:

an upstream and downstream passage and wherein said at least two operational modes comprise a pumping mode, an armed mode and a bleed-off mode;

said pumping mode adapted to have said chamber in checked fluid communication with said downstream passage thereby preventing fluid flow from said chamber into said downstream passage, and in checked fluid communication with said upstream passage thereby preventing fluid flow from said chamber into said upstream passage;

said armed mode adapted to have said chamber in unchecked fluid communication with said downstream passage and in checked fluid communication with said upstream passage thereby preventing fluid flow from said chamber into said upstream passage; and

said bleed-off mode adapted to have said chamber in unchecked fluid communication with said downstream passage and in unchecked fluid communication with said upstream passage.

5 109. The device of claim 102, wherein said chamber has a pumping region, an armed region and a bleed-off region, a pumping-armed transition point and an armed-bleed-off transition point;

a downstream check valve and an upstream check valve;

10 said downstream check valve and said upstream check valve having a checked and an unchecked position;

wherein said pressure barrier is positioned intermediate said pumping region and said armed region at said pumping-armed transition point; and
said pressure barrier is positioned intermediate said armed region and said bleed-off region at said armed-bleed-off transition point.

15 110. The device of claim 109, wherein said pressure barrier is positioned operationally proximate said downstream check valve at said pumping-armed transition point.

20 111. The device of claim 109, wherein said pressure barrier is operationally positioned proximate said upstream check valve at said armed-bleed-off transition point.

112. The device of claim 102, further comprising:

said at least one chamber comprises an upstream chamber and a downstream chamber;

said at least two operational modes comprise a pumping mode and an armed mode;
an upstream passage and a downstream passage;
said upstream passage in fluid communication with said upstream chamber and said
downstream passage in fluid communication with said downstream chamber;
5 said pumping mode having said upstream chamber in checked fluid communication into
said downstream passage; and
said armed mode having said upstream chamber in unchecked fluid communication with
said downstream passage.

10 113. The device of claim 112, further comprising:
a spool intermediate said downstream passage and said upstream passage;
said spool having a downstream check valve, an upstream check valve and an open
passageway;
said downstream check valve and said upstream check valve each having a checked and
15 an unchecked position; and
said spool movable to selectively position one of said downstream check valve, said
upstream check valve and said open passageway in fluid communication with said
downstream passage and said upstream passage.

20 114. The device of claim 102, further comprising:
said pressure barrier having a first extreme position, a first near extreme position, at least
one other extreme position and at least one other near extreme position;
each of said at least two operational modes having a beginning and an end;

said at least two operational modes comprising a pumping mode and an armed mode;
said pumping mode beginning with said pressure barrier in said first extreme position and
ending with said pressure barrier in said at least one other near position; and
said armed mode beginning with said pressure barrier in said first near extreme position
and ending with said pressure barrier in said at least one extreme position.

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